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6. AUTHOR(S)

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Using a new technique based on the fanning of a coherent light beam in a photorefractive BaTiO<sub>3</sub> crystal, the angular distribution of forward light scattering by quartz fibers of radii from 15  $\mu\text{m}$  to 30  $\mu\text{m}$  has been measured. Data have been obtained over the angular range 0.0° to 0.3°, and are in good agreement with theory. Beam fanning and two beam coupling techniques have been compared for this application.

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# Light Scattering Studies at an Angle of Zero Degrees

## FINAL REPORT

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Texas A&M University  
May 5, 1994

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## A. STATEMENT OF THE PROBLEM STUDIED

An innovative idea that permits light scattering measurements at an angle of zero degrees has been demonstrated by our group. The idea is based on the use of coherent beam coupling in a nonlinear, photorefractive crystal of  $\text{BaTiO}_3$  to separate the scattered light from the unscattered direct beam. The present problem is to extend these ideas to angular distribution measurements and to compare the techniques of beam fanning and two beam coupling.

## B. SUMMARY OF THE MOST IMPORTANT RESULTS

The angular distribution of forward light scattering from quartz fibers of radii from  $15\text{ }\mu\text{m}$  to  $30\text{ }\mu\text{m}$  was successfully measured. Data have been obtained at a wavelength of  $514\text{ nm}$  in the angular range of  $0^\circ$  to  $0.3^\circ$  with an angular resolution of better than  $0.005^\circ$ ; this is the first time such measurements have been possible in this important angular region. The results are in good agreement with theory and have been submitted for publication. For complete details see publications 3 and 4 below.

As for the comparison between beam fanning and two beam coupling, the beam fanning geometry has the advantage that it is relatively insensitive to noise and vibrations, but has the disadvantage of systematic effects due to Bragg scattering. These aspects would be reversed for two beam coupling in which the scattering particle is in only one of the two beams incident on the crystal. The effects of Bragg scattering in the two cases can be understood as follows:

In beam fanning a scattering particle shifts the phase of the  $0^\circ$  scattered light. Given sufficient time this scattered light would undergo beam fanning in the crystal and set up a grating that deflects it. However, this new grating would be completely set up by light that only differs in phase from the unscattered beam. Consequently, this new grating will be identical to the grating already produced by the unscattered beam; Bragg scattering will therefore immediately deflect the beam produced by scattering at  $0^\circ$ .

On the other hand, with two beam coupling the light scattered at  $0^\circ$  is in only one of the beams. Again, given sufficient time, this scattered light will interfere with light from the second beam and would produce a new grating that deflects it. However, this new grating will be quite different from the original grating set up by the two unscattered beams, because for the new grating only one of the interfering beams has a phase shift in it. Thus the light scattered at  $0^\circ$  will not Bragg scatter off the original grating; it will pass through the crystal undeflected until its grating can be set up. Consequently, a two beam coupling scheme could significantly improve these  $0^\circ$  scattering measurements.

#### **C. LIST OF ALL PUBLICATIONS AND TECHNICAL REPORTS**

1. Choonghoon Oh, Kelly T. Andrews, Edward S. Fry, G. J. Dunning, M. L. Minden, and D. M. Pepper, "Scattering of Phase Conjugated Light by a Stationary Particle", submitted to the proceedings of the 1993 Edgewood RDEC Scientific Conference on Obscuration and Aerosol Research, Sept, 1993.
2. Choonghoon Oh, G. G. Padmabandu, and Edward S. Fry, "Angular Distribution of the Forward Light Scattering From a Quartz Fiber", submitted to the proceedings of the 1993 Edgewood RDEC Scientific Conference on Obscuration and Aerosol Research, Sept, 1993.
3. Choonghoon Oh, G. G. Padmabandu, and Edward S. Fry, "Angular Distribution of Forward Light Scattering by a Quartz Fiber", submitted to Applied Optics, May 5, 1994.
4. Choonghoon Oh, "Measurement of Forward Light Scattering Using a Barium Titanate Crystal as a Novelty Filter", PhD. Thesis, Texas A&M University, August, 1993.

#### **D. LIST OF ALL PRESENTATIONS**

1. Edward S. Fry, G. G. Padmabandu, and Choonghoon Oh, "Angular Distribution of Electromagnetic Scattering Near Zero Degrees," Presented at the 1993 ERDEC Scientific Conference on Obscuration and Aerosol Research, Aberdeen Proving Ground, MD, June, 1993.
2. Choonghoon Oh, Kelly T. Andrews, Edward S. Fry, G. J. Dunning, M. L. Minden, and D. M. Pepper, "Scattering of Phase Conjugated Light by a Stationary Particle", Presented at the Annual Meeting of the Optical Society of America, Toronto, Canada, October 3-8, 1993.
3. G. J. Dunning, M. L. Minden, D. M. Pepper, Choonghoon Oh, Kelly T. Andrews, and Edward S. Fry, "On the Propagation of Phase-Conjugate Fields Through Dynamically Scattering Media", Presented at the Annual Meeting of the Optical Society of America, Toronto, Canada, October 3-8, 1993.

**E. LIST OF ALL PARTICIPATING SCIENTIFIC PERSONNEL SHOWING ANY  
ADVANCED DEGREES EARNED BY THEM WHILE EMPLOYED ON THE  
PROJECT**

Edward S. Fry

G. G. Padmabandu

Choonghoon Oh received his PhD.

**F. REPORT OF INVENTIONS**

None

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